Ad#1

3rd Party Administrator requirements.

Any Plant that has not been audited by the 3rd Party Administrator will be required to submit an audit summary of their Quality system to show compliance with this QA/QC manual and PPI's Protocol. This protocol will be available to the plants through a link on the HQS web site. The audit summary will be sent to PPI by April 1 of the following year. The audit summary will include evidence that the quality system is implemented. The Hancor Quality department will provide the guidelines and audit questions for this audit summary through the HQS website. The Quality Department will also monitor those plants that were not audited in the calendar year and help those plants prepare the audit summary for submission to the Administrator.

Ad#3

Florida Department of Transportation (FDOT)

Per FDOT **July 2002 Supplemental Specifications section 948-1.7**, pipe certifications provided for FDOT jobs will include “mean or average” inside diameter tests results for the certified lot of product. (see Attachment 8 - example of a Certificate of Analysis).

A#5

Eastern States' Consortium (ESC) Quality Control Requirements For HDPE Pipe Producers should be reviewed by the plants production and quality leaders and pertinent information shared with all associates. This is available through the Hancor ITP HQS system.

The following table lists those plants and products that will be listed for approval through this program.

Plant	Address	Plant Leadership	Products for listing (per M252 & M294)
Vermont	30 Precision Drive N. Springfield, VT 05150 802-886-8403	Ken Gaston – Plant Manager Jason Cram – Quality Leader	4" – 24" Type C, CP and 4" – 30" Type S, SP
New York	1 William Donnelly Pkwy. Waverly, NY 14892 607-565-3033	Dave Markie – Plant Manager Don Baer – Quality Leader	4" – 24" Type C, CP and 4" – 48" Type S, SP
North Carolina	5816 Hwy 70 East Mebane, NC 27302	Bert Austin – Plant Manager Jeff Jones – Quality Leader	4" – 24" Type C, CP and 4" – 30" Type S, SP
Ohio – South Plant	12370 Jackson TR 172 Findlay, Oh 45839	Steve Farrow – Plant Manager Dan Reddick – Quality Leader	4" – 18" Type C, CP, S, SPl
Ohio-Hantech	433 Olive St. Findlay, Ohio	Clark Inniger – Plant Manager Charlie Groves – Quality Leader	24" Type C, CP and 24" – 48" Type S, SP

Ad#6

National Transportation Product Evaluation Program (NTPEP). Plant will read and follow the particular instructions within the document. This document can be found on Hancor ITP under the HQS section.

Ad#7

Indiana Department of Transportation requirements.

Each month a summary report of production and material test results will be forwarded to the Indiana DOT. The type of information provided will be agreed upon between Hancor and Ind. Dot personnel. Any changes/revisions to the type of information provided will be approved between Hancor and Ind Dot prior to submission.

1. **Hancor Quality Department will be primarily responsible for providing the summary report each month.**
2. **This report will be submitted to Ind Dot no later than the 15, 16, or 17th of the following month for the prior month results.**
3. **The plants QC/materials associates will provide their plants results to Hancors' Quality department on or before the 10th of each month.**

Addendum 4 – Use of Purchase Recycled materials in the manufacture of Pipe

SECTION 3

Raw Material Identification, Traceability and Testing

3.1
A lot control number or purchase order number traces all incoming materials. Records used to identify lots and their origins are maintained in the Central Laboratory and in the computer system. The following table summarizes the sampling frequency for the various methods of receiving raw material.

Raw Material Delivery	Sampling Frequency (2)	Work Instruction #
Rail Car (1)	**A minimum of one sample from lower portion of rail car compartment. (purchased reprocessed pellets)**	RM-WI-2 RM-WI-3
Tractor Trailer Truck	**One sample per tanker truck provided by truck driver. (safety issue) (purchased reprocessed pellets)**	RM-WI-2 RM-WI-3
Boxes	**A minimum of one sample from each box.** (includes virgin and purchased recycled materials)	RM-WI-2 RM-WI-3

(1) OSHA safety rules must be followed when sampling top compartments of rail cars. If the plant does not have the required safety equipment then only the bottom compartments will be sampled.

(2) In lieu of sampling, the virgin suppliers Certificate of Analysis (COA) test data may be used or historical test results based upon statistical analysis for regrind suppliers may be used. When this occurs, for both virgin and recycled materials suppliers, random sampling and testing will still be done for Quality Assurance purposes.

It should be noted, that HANCOR uses the term "box" for rail and truck compartments as noted on Form # LAB-F-2 (See Attachment 2). See **reference documents** 2 and 3 for receiving and sampling of raw materials.

3.2
Each sample is bagged using a 6"x9" baggie and marked with the appropriate lot control number –usually the purchase order number. This identification system is retained through all phases of manufacturing process to provide 100% traceability. Each baggie is filled at least half way with material from the box or compartment.

3.3
A history file is maintained for a minimum of 5 years at the Central Laboratory and/or Home Office for each material lot. This file contains supplier information, the results of the laboratory testing and additional information.

3.4
Samples of the material are sent to the Central Laboratory where testing is performed to determine the material's physical properties. Every load of HDPE recycled materials – see 2.1 note 2 above) received by the plant is either sampled by the plant and/or supplier is on pre-approved list and material properties are pre-assigned. See section 3.9 below. Materials will not be used by manufacturing unless they have been tested and approved by the Central Lab. Testing by the Central Lab includes, but is not limited

to, the following: (see reference document 4 – Central Lab Operations and Scope (SOP 8.1)).
Material lot # is defined as the P.O. number. The quantity within that material lot is found on the P.O. document and certification documents. These amounts can vary depending upon transportation type (e.g. railcar or tanker).

Raw Material Testing[1] (for virgin and recycled materials)		
Type of Test	**ASTM Test Standard (Hancor Procedure)**	**Test Frequency**
Melt Index [2]	ASTM D1238 (Lab-WI-10)	Each compartment of a rail car or three random on a box shipment (recycled)
Density [2]	ASTM D1505 (LAB-WI-14)	Each compartment of a rail car or every 5th box of shipments (recycled)
Flexural Modulus	ASTM D 790 (Lab-WI-08)	Random [3]
Tensile Strength	ASTM D 638 (Lab-WI-17)	Random [3]
ESCR or NCTL	ASTM D1693 or D5397 (Lab-WI-12 and Lab-WI-05)	Random [3]
Carbon Black	ASTM D1603 (Lab-WI-02)	5 random samples from each shipment (if necessary) [4]
Izod Impact [6]	ASTM D256 (LAB-WI-31)	Each compartment of a rail car or three random on a box shipment of recycled
Contamination Test [5] [6]	Lab-WI-04 and (Lab-WI-06)	Every box of regrind (Lab-WI-04 only and recycled only)
IR Scan [5] [6]	(LAB-WI-13)	5 randomly selected samples from box shipment or 2 samples from tanker shipment. Repro pellets only)

Notes:
1. Supplier certification as to the physical properties may be used to determine acceptability of the material. **See section 2.9 below.**
2. Melt Index and Density are the primary tests that are done to accept or reject a material. If these properties are with in specification, the other properties such as tensile strength and flexural modulus will also be in specification. (see Phillips Petroleum report).
3. Not only are these properties randomly checked, but also results from the Izod test may trigger the need for the ESCR and tensile strength testing.
4. When the raw material is a carbon black concentrate, this test is performed.
5. In the case of purchased regrinds or reprocessed pellet materials additional steps and tests may be performed to characterize the material and to prevent contamination (i.e. other types of plastic or non plastic material).
6. Not required by AASHTO material requirements, however, these are important for purchase regrind quality control.

3.5
The preceding tests are performed in accordance with the requirements of ASTM D3350 as designated by AASHTO M252 and AASHTO M294. This testing is performed to assure that the pipe material meets the cell classification as required by the appropriate specification. Once per

month a sample will be pulled from a process producing AASHTO product and that material will be tested for the complete cell class properties. Test results are available for review upon request by customers (DOT's).

A general description of these raw material tests are summarized as follows:

3.5.1 Density

Density is the first digit in the cell classification system established by ASTM D3350. The density test is performed in accordance with the ASTM D1505 or equivalent as described in methods A or B of Test method ASTM D792.

3.5.2 Melt Index

Melt index is the second digit in the cell classification system established by ASTM D3350. The melt index test is performed in accordance with the ASTM D1238.

3.5.3 Flex Modulus

Flexural modulus is the third digit in the cell classification system established by ASTM D3350. The flexural modulus test is performed in accordance with ASTM D790, except some modification, which are specified in ASTM D3350. This test procedure essentially requires that a plaque be placed on a test apparatus and loaded at a rate of 0.5 inch per min. The load is measured at a certain strain (2.0%) and a corresponding value for flexural modulus is determined. Flexural modulus is measured in pounds per square inch.

3.5.4 Tensile Strength

Tensile strength is the fourth digit in the cell classification system established by ASTM D3350. The tensile strength test is performed in accordance with ASTM D 638, except some modifications specified in ASTM 3350. The test procedure essentially places a dog bone shaped sample in two grips and pulls on the sample.

3.5.5 Environmental Stress Crack Resistance (ESCR/NCTL)

ESCR or NCTL is the fifth digit in the cell classification system established by ASTM D3350. The ESCR or NCTL test is performed in accordance with ASTM D 1693 or ASTM D5397. The test procedure essentially places a notched sample in an Igepal solution (a strong detergent) at an elevated temperature.

3.5.6 Percentage of Carbon Black

The carbon black content of a given cell classification is designated by the letter "C" at the end of the cell classification system established by ASTM D3350. The percentage of carbon black is determined in accordance with ASTM D 1603. The carbon black percentage is based on a percentage of total weight. The final product is randomly tested to assure proper carbon black content.

3.5.7 Contamination test (for non-AASHTO products only)

This test is used on purchased regrinds to identify non polymer materials (metal, wood, paper, etc) and to identify non polyethylene materials (polypropylene, polystyrene, nylon, etc) that can be introduced into this material through the sorting and regrinding process at those facilities that provide this material to the market place. The basic process for determining contamination is to sample each container then drop a portion into water and look at the material that sinks (contaminates). Since polyethylene and other plastics may float on water (I.e their density is less than 1) then the next step is to make up an alcohol/water solution with a certain density that will sort out those other plastic material

contaminates. For further details see the work instructions associated with this test. An extruder test may also be run on the materials to determine processability, to look for internal trapped moisture that may be present in reprocessed pellets and to find other contamination such as non plastics or plastics that do not melt at the same temperature as PE.

3.5.8
The Izod impact test measures the toughness or impact resistance of a plastic. This property helps predict whether the product will survive (not crack or break) during handling of the product at the job site.

3.6
As raw material tests are performed, the results are logged onto the appropriate quality form (i.e. LAB-F-2). This form is an electronic form maintained in a database.

3.7
If the raw material meets the requirements as identified above, the material is passed for manufacturing to ASTM F405 and ASTM F667 or to AASHTO M252 and AASHTO M294 if acceptable to specific DOT's. A computer is used to forward the test data to the manufacturing plant and to store the test results.

3.8
If any lot of raw material is found nonconforming, the material may be re-sampled and re-tested. If the material is still found nonconforming, the material is rejected back to the supplier. A thorough investigation of the nonconforming material supplier is undertaken, as detailed in Section 8 of this document. See reference document 5 – Control of Non-Conforming Product (SOP 8.5).

3.9
As test data of material suppliers is gathered and subsequently analyzed for variation and adherence to specification, those suppliers who show consistent results will not be tested by the Central Lab on a 100% inspection basis but the statistical averages will be used. Those suppliers who meet this criteria tend to supply a known single steam of material thereby providing consistent material properties. The Central Lab will perform skip lot sampling of those suppliers for verification purposes. All virgin material lots from the NY, VT, NC and both Ohio plants will be sampled and sent to the Central lab for verification of Melt Index and Density.

SECTION 4

Finished Product Identification, Traceability and Testing

4.1
Once the material has been approved for use, the manufacturing plant raw material control person sets up the blending equipment to produce a material blend (i.e. a virgin lot of raw material and black concentrate). A raw material blend number is assigned to each blend of materials. A copy of the blend record is maintained and can be accessed in the database for all plants. Once per month the raw material control person will send to the Central Lab a sample of material blend a long with the blend sheet so that the Central Lab can verify the material properties meet the ASTM and or AASHTO material requirements requirements. The Central Lab will notify the plant when there is an issue, otherwise the results will be documented in a spreadsheet and saved for future reference.

4.2
All parts and products are designed to meet ASTM and/or AASHTO specifications. HANCOR permanently marks the finished products with the company name, pipe size, product description, and a date code. Part number, date code and vendor code identifies all other components. A typical example of a date code identification is "0528972UU", which represents a product, manufactured May 28, 1997 on the second shift at the corrugated line (UU) in the Yoakum, Texas manufacturing plant. **See attachment 7 – Date Code Marking print.**

4.3
Each shift and production line documents the material used (as identified by the blend number) during the shift. Attachment 4 contains a blank copy of the First Piece Verification form. This form includes information to document the date code of the product and the raw material blend used for that product during the manufacturing process. Therefore, a system is in place to account for 100% traceability of the material used to manufacture a particular product and allow for the review of dimensional and performance tests. The date code that is marked on the product is the manufacturing date that is recorded on the operators log.

4.4
During production a minimum of the following checks are performed at the manufacturing plant: See attachment 3 – A typical pipe control plan for more detail.

Pipe Production		
Test Description [1]	**Hancor Verification Method (VM)**	**Frequency of Test [2]**
Weight per foot	VM - 1	1 sample/hr – CC[3]
Inside diameter	VM - 3	1 sample/shift
Outside diameter	VM - 4	1 sample/ shift
Liner flatness	VM - 5	1 sample/shift
Perforation pattern	VM - 7	1 sample/shift
Perforation Inlet area	VM - 7	1 sample/shift
Liner thickness	VM - 9	1 sample/ hour- CC
Sidewall % variation	VM - 10	1 sample/ hour -CC
Crown Thickness	VM - 9	1 sample/ hour -CC
Product Length [4]	VM-13	1 sample/ shift

Note:

1. Depending upon product type, manufacturing process and design, other dimensional tests may be included for testing to assure product quality.
2. These test frequencies may be increased or decreased if determined necessary because of statistical quality control calculations unless decreasing would violate a customers requirements. Frequencies will not be reduced below customer requirements.
3. CC is equal to Control Chart. Product specification limits or statistically derived limits may be used.
4. The product length measurement is conducted at ambient room temperature due to extra long measurements (20 feet – 40 feet) of our product offerings. The process, including mold blocks, were designed to account for shrink rates of plastic after processing. Also, the products are cut to certain dimensions to allow

for shrinkage and to assure that the minimum length will not violate the customer requirements. Hancor's Central lab studied the shrink rates of product to assure the design criteria and manufacturing cut instructions were sufficient.

4.5

These tests, described in section 3.4, above, have been identified as "Critical to Quality" for two reasons. First, some of the dimensional tests will predict the finish product performance capability (i.e. impact resistance and parallel plate strength). Secondly, some tests are required by specification (i.e. ASTM, AASHTO, etc.). As described in Section 7, this information is recorded on the First Piece Verification Form (see Attachment 4). The following is a brief description of the test described in section 3.4:

4.5.1 Weight

The weight per linear foot is checked at a minimum of every hour of production. This is an important parameter, since it is indirectly related to the pipe stiffness.

4.5.2 Thickness

Thickness is checked at a minimum once every two hours of production. The procedure for this quality control check is performed in accordance with ASTM D2122. Hancor personnel checks several locations of the pipe profile to assure that minimum thickness are met or exceeded. Among the thickness' checked are the crown thickness, liner thickness, root thickness, and sidewall thickness.

4.5.3 Liner Flatness

Hancor personnel checks the liner flatness of the finished produce. The flatness of the liner refers to the liner rippling. The procedure for this quality control check is performed in accordance with ASTM D2122. This test checks for excessive liner rippling and assures the hydraulic capacity of Type S and Type SP products.

4.5.4 Diameters

Diameters are checked routinely. The outside diameter and inside diameters are checked once every shift during production. The procedure for this quality control check is performed in accordance with ASTM D2122.

3.5.5 Marking Verification

Marking verification is checked at a minimum once every two hours of production. This procedure is performed to maintain compliance with appropriate ASTM or AASHTO specification. All pipes are required to have marking permanently affixed at intervals no more than every 10 feet. The following is the minimum required information: Manufacturer or trademark, Nominal size, Specification designation and Date of manufacture.

4.6

In addition to the testing described above, a number of tests are performed on the finished product. These tests are as follows: (**See reference document 6 – In-Process Quality Assurance Testing (GEN-WI-1)** for additional detail. M252 test and their frequencies are, also, mentioned in GEN-PROD-WI-1 document). See Control Plans for more explanation.
When products are produced in accordance with AASHTO specifications but use non-virgin raw materials and the product is accepted by the customer (i.e. DOT) all performance property tests and material properties still need to meet the requirements of AASHTO (except for virgin vs non-virgin description).

Test Description (3)	Test Standard (2)	Test Frequency –QC (4)	Test Frequency – QA (4)
Pipe Stiffness @ 5%	ASTM D 2412	2 times per 24 hrs	Per 2 day lot size
Pipe Flattening @ 20%	ASTM D 2412	2 times per 24 hrs	Per 2 day lot size
Cold Temperature Impact	ASTM D 2444	2 times per 24 hrs	Per 2 day lot size
ESCR	AASHTO M294/MP7		One time per production run
Marking Verification	AASHTO M294/MP7	2 times per 24 hrs	
Visual	AASHTO M294/MP7	2 times per 24 hrs	
Alignment Test	AASHTO M294/MP7		One time per production run
Joint Integrity	AASHTO M294/MP7		One time per production run
Elongation	AASHTO M252 type		One time per production run
Low temperature	AASHTO M252 type		One time per production run

Note:

1. These test frequencies may be increased or decreased if determined necessary because of statistical quality control calculations. Frequencies will not be reduced below customer requirements.
2. The test standards used are those referred to in the appropriate ASTM/AASHTO standards.
3. The test description typically is for Quality Control testing. However, for ASTM/AASHTO certification testing the sampling frequencies and testing conditions are different. Refer to the control plan and the reference document #6 for more information.
4. QC tests are done as production is being run. QA test are done once production is over or a 2 day lot is established. QA tests are done with condition times per the standard. QC test are done with modified conditioning times. See GEN-WI-1 for QA test info and control plans for QC testing info in section 2 Attachment 3 of the manual.

4.7

The testing described in the preceding Sections 4.4, 4.5 and 4.6, are performed in accordance with the requirements of ASTM and AASHTO M294 for diameters 12" – 60" and M252 for diameters 3"- 10". These have been identified as "Critical to Quality" test for two reasons. First, some of the dimensional tests will predict finished product performance capabilities (i.e. impact resistance and parallel plate strength). Secondly, certain tests are required by specification (i.e. ASTM and AASHTO). The following is a brief description of some of the more involved testing standards noted in Section 3.6.

4.7.1 Cold Temperature Impact Testing

Impact testing varies from once every hour to once every shift of production. The frequency of testing is dependent upon the diameter of pipe. The procedure for this quality control check is performed in accordance with ASTM D 2444. In the case of AASHTO M 294 products, the samples to be tested are left in a freezer for a minimum of 24 hours at 25 degrees Fahrenheit. The sample is then tested within 60 seconds from the time it is pulled from the freezer.

4.7.2 Pipe Stiffness (@ 5% and 20% deflection)

Parallel plate tests are performed at a minimum once per shift of production. The procedure for this quality control check is performed in accordance with ASTM D2412.

Hancor personnel checks several samples of the pipe being manufactured. This testing involves testing the pipe for both the pipe stiffness at 5% deflection and checking for splitting at a 20% deflection at 70 -77 degrees F room temperature. Additionally, at 20% deflection the pipe is required to continue carrying a load. Attachment 5 is an example of the pipe stiffness test equipment printout.

4.7.3 Environmental Stress Crack Resistance (ESCR)

Environmental stress cracking tests are performed following a modified version of ASTM D1693. This test is done for certification testing.

4.8

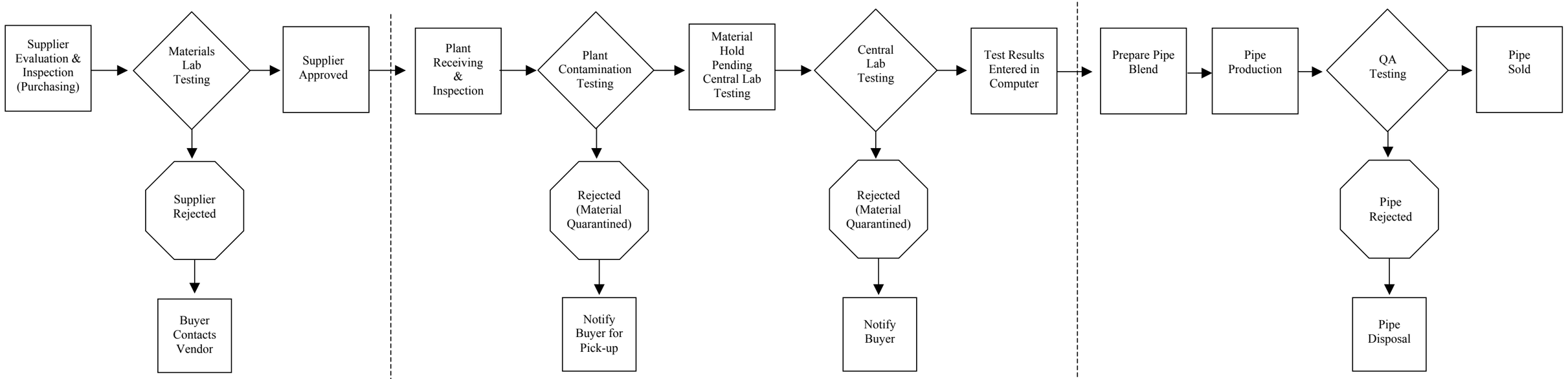
This finished product testing is performed at the manufacturing plant's laboratory or the Central Laboratory. In those cases where the finished product testing is performed at the manufacturing plant, samples are submitted to the Central Laboratory periodically for quality assurance and audit verification.

4.9

Once the testing is performed, the test data is stored. This stored data is referenced by the date code (i.e. plant, shift, production line and date). This information is stored for a minimum of 5 years. Detailed information regarding this documentation is contained in Section 7. Test data may be stored on computer disk or paper copy. Form ST-7 (reference document # 7) is used by the plants and the testing lab to communicate the submittal of samples for testing and the recording of the results back to the lab and plant.

Addendum 4A

Purchased Raw Material Recycled Supplier Qualification & Quality Control Acceptance Testing



Supply Chain Audit

- Purchasing provides test sample to Materials Lab.
- Materials Lab tests for physical characteristics (including melt index, contamination, IR scan, density, Izod impact, extruder test and particle size distribution).
- Material Lab reports to purchasing as to acceptability of sample.
- If sample is rejected purchasing will contact supplier.
- Approved material containers are identified with a P.O. and container numbers.
- Each box is sampled by probing two diagonal corners with a grain probe.
- Sample material placed into bags identified individually with P.O. and container number.

Internal Audit

Raw material test form completed for each P.O.

- Sample bags go to Plant Lab for contamination testing using Lab-WI-4 work instruction.
- If material has excessive contamination or is otherwise unusable, containers and P.O.s will be rejected and placed in a non-conforming area.
- Contamination testing results recorded on test form.
- Test form and remainder of accepted samples sent to the Central Testing Lab for more thorough testing.
- Each P.O. placed on hold pending acceptance and release by the Central Lab.

- Individual boxes or rejected P.O.s will be tagged with a reject sticker and moved to a non-conforming area.
- Material visually graded and regrinds separated into similar types.
- At a minimum the following tests are run on all P.O.s: Contamination tests (water test and alcohol test) melt index, density, Izod impact, IR scan (reprocessed pellets only) and Extruder test.
- Test results are input on computer form number LAB-F-2. Average value of the results will be entered into the JD Edwards material control section for plant use. Rejected or partially rejected loads are recorded on form #101 and attached to LAB-F-2 for buyer review. For rejects, the buyer will send Form 102, corrective action response, to the supplier

Production Audit

- Unacceptable boxes or containers are also identified and separated out or tagged with reject stickers.
- Using the test results and combining the different P.O.s in precise percentages, a material blend is created with the appropriate physical properties (melt index, density and Izod impact). Each raw material blend is assigned a distinct blend number that is used for traceability.
- Production Operator fills out appropriate production/quality forms and starts pipe production. Raw material blend number is recorded along with product description, date of manufacture, etc. (These documents are part of the traceability information.)
- Production quality assurance testing is started following prescribed control plans and associated quality documents. These AASHTO required post product tests include cold temperature impact, pipe stiffness, dimensionals, etc.

Hancor Technology · Innovation · Solutions

EcoFirst

Green Performance The Standard in Recycled Plastic